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IMPACT OF AFRICAN DEVELOPMENT BANK-COMMUNITY BASED AGRICULTURAL AND RURAL DEVELOPMENT PROJECT ON RURAL MAIZE FARMER'S OUTPUT IN KADUNA STATE, NIGERIA

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ABSTRACT

The main thrust of this study is to examine the impact of adopting African Developmnt Bank-community based agricultural and rural development project among rural farmers on maize output in Kaduna State, Nigeria. The study utilized primary data sources. The sample consists of 361 beneficiaries drawn from the three participating local government areas selected from the three senatorial zones of the state. More so, 361 non-beneficiaries were randomly selected from the syndicated study area. A well-structured questionnaire was then utilized to elicit information from the respondents. Thereafer, the logit

Introduction

Maize farming is an important source of livelihood for the rural poulation in most African countries, including Nigeria, due to its significant contribution in food security, poverty reduction, and job creation, as well as a source of raw materials for emergent industries (Joana, Daniel & Frank, 2021). Despite these substantial contributions, a World Bank report (2015) submits that agricultural yield in Sub-Saharan African (SSA) countries continues to lag behind. This makes achieving food security and poverty reduction impossible for African countries. According to Mensah-Bonsu, Sarpong, Al-Hassan, Assuming,Egyir, John, and Osei-Asare (2017), the agricultural sector's impact in SSA countries is extremely below anticipated potential levels. The study attributed the yield gap to the inability of SSA countries to take full advantage of the agro-tech advancement that is being practiced globally (Joana, Daniel & Frank, 2021).

This raised the question of how farmers in Sub Sahara Africa, such as Nigeria, and particularly farmers in rural areas, could stimulate production by adopting improved agro-tech and modernized farm inputs. Improved technological adoption however, is key to stimulating small-scale farmers' agricultural output and livelihoods in rural developing nations. Improved seeds are a prerequisite to boosting agricultural yield and achieving global food security (Almekinders, Beumer,Hauser, Misiko, Gatto, Nkurumwa, & Erenstein, 2019). Improved seedlings are high-yielding, disease-

regression method was applied, hence, the forward stepwise wald was used to assess the models' classification accuracy and goodness of fit. The method generated four (4) steps, but for the purposes of determining accuracy in terms of maize output classification, attention was focused on step (4), which yielded the highest classification accuracy with the highest adoption of the explanatory variables, compared to step (2) and (3). The result found that the adoption of IMS, FLW, FET, and AGT had a significant positive impact on maize output in the study area at 5% level of significance. Therefore, the study recommended that government should encourage rural farmers to join farmers union in other to benefit from similar opportunities, like the (AFDB-CBARDP) and also encourage savings amongst the farmers. Additionally, the government should step up its efforts in linking the rural areas to urban cities through quality road infrastructures.

Keywords: Logit, Rural area, Maize farmers, maize output, improved seedlings

resistant, drought-tolerant, and respond well to inorganic fertilizers (Lee, 2020; Simtowe,Amondo,Marenya, Sonder,Erenstein, 2019), whereas traditional seeds have poorer yields but are more able to acclimatize to the local environment (Lee, 2020; Simtowe,Amondo,Marenya, Sonder,Erenstein, 2019, Anang, 2019).

In the light of this expectations the federal government of Nigeria adopted a community-based development (CBD) in 2001 aimed at re-engineering agricultural productivity particularly, in the rural areas. In this regard, the African Development Bank (AfDB) devised a Community-Based Agriculture and Rural Development Project (CBARDP) intervention programme for the country in partnership with the Federal government of Nigeria. The project was approved in 2003,and began in 2005. The programme made its first disbursement to beneficiaries in June 2006. The project covered the states of Adamawa, Bauchi, Gombe, Kaduna, and Niger State (KADP-PCU, 2006). In Kaduna State, the participating local government areas include; Birnin Gwari, Kaduna South, Igabi, Ikara, Sabon Gari, Zaria, Kachia, Jaba and Sanga with 27selected rural village areas (RVAs) (KADP-PCU,2006).

Since the launch of the AFDB-CBARDP in 2005, copious agricultural technologies have been launched and delivered to farmers in the five participating states under eight schemes that cover crop, poultry, livestock, processing, and cow rearing, among others (Solomon, Esther, & Michael, 2020). Crop technologies such as extra early maize, with the agronomic techniques were introduced under the agricultural program (Solomon, Esther, & Michael, 2020).

Kaduna State however, has a comparative advantage in the production of cereal crops such as maize than other states of Nigeria, due to its eco-system and soil fertility. As a result of its comparative advantage, the state produces the highest tonnes of maize, with 2,166,799.8 tonnes produced in 2016 (KASS, 2017). This indicates that the state produces 22 percent of Nigeria's total maize production (KASS, 2017). Unfortunately, the agricultural yield of maize in Kaduna State has been erratic, it runs backwards as easily as forwards, despite the state's cereal crop producing potential. Incidentally, Food and Agriculture Organization (FAO, 2018), reported that Nigeria maize production in 2018 was 11 million metric tonnes (MMT), while maize consumption was 11.4 million metric tonnes (MMT), indicating about 400,000 tonnes deficit. FAO (2018) estimated that Nigeria's maize production for 2020 would be about 11.1 million tonnes, implying that about 300,000 tonnes to plug the production shortfall. Consequently, this deficit, implied production or yield gap. In addition to this, consider the fact that majority of the rural farmers are low-income earners with high poverty index, scaling up production to meet with demand is difficult. Hence, maize deficit may persist as poverty continues to rise. The country may have to continue to import maize to plug the production shortfall. The question that this present research tends to answer is; what is the impact of AFDB-CBARDP adoption on the productivity of maize by the rural maize farmers in Kaduna State. Given the foregoing, the objective of this study therefore, is to examine the impact of AFDB-CBARDP adoption on maize output by the rural maize farmers in Kaduna State, Nigeria.

Literature Review

The theoretical underpinning of this study is drawn from the modernization theory. In the perspective of the modernization theory postulated by Schultz (1964), as societies modernize, they abandon their historical agrarian lifestyles in favor of modern industrial or technological lifestyles; at the very least, they modernize their cultural agrarian lifestyles, resulting in economic opulence. Modernization in this context, connotes a transition from traditional farming to modern agriculture in emerging nations. In this perspective, the AFDB-CBARDP was designed in a trajectory of modernization. Due to the fact that, the AFDB-CBARDP objectives represnet a transition from traditional method of farming to the adoption of modernized farming with the use of modern tools. Hence, under this perspective, it is assumed that a maize farmers' decision to participate and adopt AFDB-CBARDP (or not) falls under the framework of choice modelling. As rooted in the Schultz (1964) modernization theory on how the primordial agriculture can be transmuted into a high productive type of income. Schultz held that it does not pay to invest in the crude method of farming already in existence in the rural agrarian society that held rural dwellers trapped in low productivity. In this regard, Schultz proposed that efficient modern factors should be adopted, but this is only possible if the farmers possess the capacity to do so. Given a choice of participating on the AFDB-CBARDP programme, so as to maximize the opportunity of alternative maize seed technologies (i.e. FPMS or certified hybrid seeds), the rational maize farmer will choose the option which yields the maximum benefit (i.e. profit).

Consequently, to examine the impact of adopting AFDB-CBARDP that includes maize seed technology, will require modelling within the concept of utility (output) maximization as enunciated under modenization theory. Under this theoretical concept, it was assumed that given the expected benefits and cost associated with the adoption of a particular seed technology, a maize farmer is more likely to cultivate the FPMS technology for instance, if the expected utility is higher than cultivating the alternative (i.e. certified hybrid seed) and vice versa. Hence, in a pareto sense, a rational farmer would rather accpet the opportunity to perticipate in a programmes, such as (AFDB-CBARDP) that offers the opportunity to maximize alternative maize technologies in anticipation of the intended benefits (output, welfare). Consequently, the dominant thinking in Schultz proposition is the idea that rural farmers are profit maximizers in the conventional economic sense. That is, given the inputs prices, they will choose the locus of output and input combination that guarantee profits maximization (in this case, output of maize).

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Empirical Literature

Banchayehu, Jordan , Martin and Pytrik (2021) examined the usage and impacts of technologies and anagement practices in Ethiopian smallholder maize production. The study's sample comprised 3914 maize fields for the individual management practices and 3341 maize fields for the management packages, drawn from the main maize growing areas of Ethiopia. The study used three different econometrics models to analyze the data obtaines through household survey; a multivariate probit model, a multinomial logit model, and a multinomial endogenous treatment effects model. The study's finding revealed that technology adoption and Integrated management contributed to maize produce.

Nwachukwu, Felix,Bitrus and Elijah (2021) examined the impact of agricultural technologies on the output of maize in Kaduna State, Nigeria. The study utilize cross sectional survey method in sampling the opinions of the respondent. Structured questionnaire was utilized in eliciting respondents' opinions that formed the data for the study. In the study, a sample frame of one thousand, one hundred and five (1105) farmers were obtained. Hence, the study randomly selected about 10% of the total respondents from each of the study area which formed the sample size of 99 for the study. Data obtained were analyzed using 2-way ANOVA. The study found that the utilization of agricultural technologies impacts positively on maize output production and farmers income at 1 percent significance level.

Tahirou ,Tesfamicheal & Bola (2018) examined the impact of improved maize varieties in Nigeria. The study draws samples from the major maize producing regions in Nigeria throgh the adotpion of representative plot and household level data. An endogenous switching regression approach was used in the analysis of the data. Hence, the research finding showed that adoption of improved maize varieties improved maize grain produce by 574 kg/ha.

Jamilu, Abdul-Aziz, Jafaru, Sani and Abudu (2014) assessed the adoption of Sasakawa Global 2000 maize production practices among smallholder maize farmers in Kaduna State. Data for the study were obtained by the use of structured questionnaire. Twenty maize farmers were randomly selected from each of the four cells given eighty (80) respondents. Descriptive statistics and logit regression analysis were used to analyze the data. The result showed that age, education, household size, extension contact, farm yield, and access to credit were the factors influencing the adoption of SG 2000 maize production practices.

Ebojei, Ayinde and Akogwu (2012) examined the socioeconomic factors influencing the adoption of hybrid maize in Giwa local government area of Kaduna State, Nigeria. The study utilized maximum likelihood estimate of logit model in determining the factors affecting famers adoption of hybrid maize. The study specified adoption of hybrid maize as the dependent variable, while age of household, years of farm experience, family size, farm size, years of formal education, visit by the extension agents, labour, income and access to credit were utilized as the explanatory variables. The result of this study showed that the average predicted probability of technology adoption was age (x1) $P<0.013$, income (x5) $P<0.034$, education (x6) $P<0.001$ and extension visit (x7) $P<0.017$. More so, farming experience, family size, and farm size were found to have no significant influence on participation in hybrid maize.

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Methodology

Research Design

This study relied on quantitative research analysis. Data collection was done through the use of structured qustionnaire. The data obtained was thereafter analyzed using binary logitistic regression method to examine the study's objective. The Logistic Regression is appropriate when the dependent variable is categorical or dychotomous. The Statistical Package for Social Sciences (SPSS) version 25 was utilized in analyzing the data. Hence, decisions and opinions were formed based on the outcome of the regression analysis.

Study Area

The study was conducted in three local government area, drawn from the three senatorial zones of Kaduna State where the AFDB-CBARDP programme was implimented. These include; Igabi, Zaria and Kachia.

Igabi is located in Nigeria's Guinea Savannah Zone and has an area of about 445,659 km2 with a population of roughly 430,753 people according to the 2006 census (NPC, 2006). The Local Government is dominated by farmers who produce food crops on commercial level. Major crops produced are yams, maize, guinea corn, beans and sugarcane (Adepoju, Sodimu & Akande, 2019). Zaria on the other hand, is located in the heart of the northern Guinea savannah zone, on a plateau about 700 metres above sea level. The Local Government Area is located in latitude 11004' north and longitude 7042' east. The rural farmers in Zaria are known for their produce of maize, ground nut, guinea corn, and peper amongst others. Like Zaria, Kachia is situated on the equator at longitude 300E and latitude 110 301 N. There are 244,274 people living on a land area of 4,632 square kilometers (NPC, 2006). Like Zaria local government area, there are also, two seasons in Kachia: dry and wet seasons. Kachia is famously known for ginger, maize, guinea corn and rice production. However, the cropping pattern in these study areas is sole/mixed cropping and the major crops grown are: ginger, maize, sorghum, millet, rice, and cowpea. In terms of value system, the rural people in these locations have strong group cohesiveness. As such, agriculture is most significant economic activities of the rural people in the study area.

Sampling Technique

The AfDB-CBARDP had only 5 participating states (Adamawa, Bauchi, Gombe, Kaduna and Niger), as previously enunciated. The benefitting local governments in Kaduna State are Birnin Gwari, Igabi, Ikara, Jabba, Kachia, Kaduna south, Sabon Gari, Sanga and Zaria. Three (3) Rural Village Areas (RVAs) make up each benefitting Local Government Area. As such, a multi-stage sampling technique was applied to generate a representative sample of the respondents in the study areas. In the first stage, one participating local government area was selected purposively from each of the three senatorial zones of Kaduna State; Igabi local government area (Kaduna Central senatorial zone), Zaria local government area (Kaduna North senatorial zone) and Kachia local government area (Kaduna South senatorial zone). In the second stage, three (3) participating rural village areas (RVAs) were purposively selected from the syndicate local government areas, which includes; Igabi, Gwaraji, Gwada, Zaria, Wucucuri, K/galadima, Doka, Gidan Tagwai and Agunu Dutse. In the third stage, (3) non-participating rural village areas (RVAs) were also selected from the syndicate

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local government areas to provide information for comparison, which include; Igabi, Gwaraji, Gwada, Zaria, Wucucuri, K/galadima, Doka, Gidan Tagwai and Agunu Dutse. In the fourth stage, a representative sample frame of the non-participant was purposively drawn from the population of non-participant for each of the RVAs.

Consequently, using Kothari (2004) formula, the sample size that was selected from the population frame of 5892 rural maize farmers (KADP-PCU, 2006), that participated on AFDB-CBARDP was 361. Moreso, to provide information for comparison, 361 respondents were purposively selected from the population frame of non-participants.

Table 1: Sample Size and Rural Village Areas (RVAs) of the Participating Syndicate Local Government Areas

Zone	LGA	Participating RVAs	Participants		Non-participating		
			Population frame	**Sample Size**	**RVAs**	**Population frame**	**Sample Size**
Kaduna Central Senatorial Zone	Igabi	Igabi	828	51	Igabi	828	51
		Gwaraji	819	50	Gwaraji	819	50
		Gwada	789	48	Gwada	789	48
Kaduna North Senatorial Zone	Zaria	Zaria	969	59	Zaria	969	59
		Wucucuri	737	45	Wucucuri	737	45
		K/galadima	665	41	K/galadima	665	41
Kaduna South Senatorial Zone	Kachia	Doka	402	25	Doka	402	25
		Gidan Tagwai	341	21	Gidan Tagwai	341	21
		Agunu Dotse	342	21	Agunu Dotse	342	21
		3	**5892**	**361**		**5892**	**361**

Source: Field Survey, 2021

Model Specification

To achieve the objective of this study, a binary econometrics modelling is critical. It has been used by various researchers in similar studies. In a study by Ebojie et al., (2012), relating to socio-economic factors influencing the adoption of hybrid maize in Giwa local government area of Kaduna State, Nigeria. Ebojie et al., (2012) specified their model as

Adoption =F (X_1, X_2, X_3, X_4…, Xn) …………………………….. (1)

Where;

Y= a dichotomous response variable such that; Y=1 if farmers adopt hybrid maize and 0 if they do not.

X_1= Age of the household head (years), X_2= Number of years of experience in farming, X_3= Family size, X_4= Farm size, X_5= Years of formal education, X_6= Visits by extension agents, X_7= labour force,

X_8= Income, X_9= Access to credit, u= disturbance term or error term which is normally indicated as zero mean and variance, B_1, β_2,… , β_9 are the coefficients of the independent variables.
In this present study, since the emphasis is on adoption of AFDB-CBARDP intervention tools by the maize farmers. Hence, the effect of the explanatory variables as seen in Ebojie et al., (2012) were replaced with the tools introduced by AFDB-CBARDP to the beneficiaries such as (Improved seedlings, farm labour wages, Fertilizers, Mechanical Technologies, and Agro-chemicals). However, farm experience (FEX) was retained from Ebojie et al., (2012) model as a control variable in this study. Therefore, the binary regression for this study is specified as:

$P_1 = \in(Y=1^1/X_1) = {}^1/_{1} + e^{(\beta_0+\beta_1 X_1)}$ ……………………. (2)

For ease of illustration, equation (4) is re-specified as;

$P_i = \frac{1}{1+e^{-2}} = \frac{e^2}{1+e^{-2}}$ ………………………….. (3)

Therefore, the likelihood of AFDB-CBARDP non adoption can then be specified as;

(1-Pi);1-P_i = $\frac{1}{1+e^{zi}}$ ………………………… (4)

As previously enunciated, the adoption or non-adoption of AFDB-CBARDP is directed as a decision involving binary response variable. Maize output was also treated as a dichotomous response, using a threshhold of 1000kg that the program tends to achieve. In-line with the objective of the AFDB-CBARDP, this is the rate estimated by the programme to assist a farmer in achieveing a better welfare. Therefore,

MOQ= β_0 + β_1IMS + β_2FLW + β_3FET + β_4AGC + β_5MET+ β_6FEX + e_i ………….…….. (5)

Where

MOQ = is treated as a dichotomous response variable such that; MOQ=1 if maize output is ≥ 1000kg, and 0 if otherwise

In line with equation (5), the logit model for the specification can be denoted as:

$L_i = \ln\left[\frac{P_i}{1-P_i}\right]$= MOQ= β_0 + β_1IMS + β_2FLW + β_3FET + β_4AGC + β_5AGT+ β_6FEX + e_i ……. (6)

In this study, the dependent and some of the independent variables (IMS, FLW, FET, AGC,and AGT) were treated as a decision involving binary response. While, the control variable (FEX) was treated as a countinuous variable. As such, the binary logistic regression is either 0 or 1. The independent variable consists some of the tools introduced by the AFDB-CBARDP.
The independent variables were measured as; IMS= adoption or non-adoption of Improved Maize seedlings (1 if adopted, 0 if otherwise), FLW= adoption or non-adoption of farm labour wage (1 if adopted, 0 if otherwise), FET= adoption or non-adoption of Fertilizers(1 if adopted, 0 if otherwise), AGC= adoption or non-adoption of Agro-chemicals (1 if adopted, 0 if otherwise), AGT= adoption or non-adoption of improved (1 if adopted, 0 if otherwise), FEX= Number of maize farming experience (in years), measured as a countinueous variable.

Discussion and Analysis of Binary Regression Results

Socio-economic Characteristics of the AFDB-CBARDP Participants and Non- Participants

Table 2: Distribution of the Respondent Based on their Socio-Economic Characteristics

Variable	Participants		Non-Participants	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Age Range		**Mean=3.39**		**Mean=3.56**
29-38	30	8.4	4	1.1
39-48	159	44.3	153	42.6

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49-58	170	47.4	199	55.4
59 years and above	-	-	3	.8
Total	**359**	**100.0**	**359**	**100.0**
Sex				
Male	168	46.8	153	42.6
Female	191	53.2	206	57.4
Marital Status				
Married	327	91.1	351	97.8
widow/widower	32	8.9	8	2.2
Household Size				
3-5	66	18.4	47	13.1
3	-	-	87	24.2
6-8	238	66.3	155	43.2
9 and above	55	15.3	70	19.5
Educational Qualification				
No formal education	54	15.0	17	4.7
Primary education	94	26.2	18	5.0
Secondary education	195	54.3	302	84.1
Tertiary education	16	4.5	22	6.1
Farm Experience		**Mean=3.99**		**Mean=3.99**
6-10 years	2	.6	2	.6
More than 10 years	357	99.4	357	99.4
Farm Size		**Mean=0.41**		**Mean=0.11**
Less than, <1.00 ha	211	58.8	318	88.6
Greater than, ≥ 1.00 ha	148	41.2	41	11.4
Labour Source				
Family	234	65.2	290	80.8
Hired Labour	125	34.8	69	19.2

Source: survey,2022

The socio-economic characteristics of the AFDB-CBARDP participants and non-participants is presented on Table 2. The profile indicate that the mean age of maize farmers is 34 years for participant, and 36 years for the non-participants. More so, a greater number of the AFDB-CBARDP beneficiaries are female with (53.2%), compared to male beneficiaries of (46.8%). A greater percentage of them are married (91.1%). The result also showed that majority of the farmers (66.3%) has a household size of 6-8. The descriptive result further revealed that majority of the farmers(54.3%) attained upto secondary education. On the average, maize farmers had a farming experience of 39 years with labour force (65.2%) primarily sourced from family. Additionally, majority of the farmers cultivate (58.8%) less than, <1.00 hectare of farm land size, indicating that 0.41% hectares of land on the average were cultivated by the rural farmers.

The implication of this findings is that farming enterprises in the syndicate study areas are family-based, hence, AFDB-CBARDP technology adoption is expected to enhanced the productivity of agricultural produce of mazie, given the fact that the rural farmers attained a minimum level of education that can guaranteed uptimum application and usage of those technologies. In this regard, efforts should be intensified through a workable policy framework that is rural based, to evolved new technologies that are adequately tailored towards igniting the interest of the farmers in adoting them, so as to scale up the size of farm land been cultivated.

AFDB-CBARDP Adoption/Maize Output Classification Accuracy

Table 3: Classification Accuracy of Maize Output of the Four Generated Logistic Regression Models

AFDB-CBARDP Beneficiaries				Non-Beneficiaries		
Observed			**Over All Percentage**	**Observed**		**Over All Percentage**
Model 1	What was your annual maize output between 2013/2018	Less than 1000kg	96.1	What was your annual maize output between 2013/2018	Less than 1000kg	57.8
Model 2		Greater than 1000kg	96.9		Greater than 1000kg	59.0
Model 3			96.9			60.7
Model 4			96.9			
a. The cut value is .500						

Source: Survey 2022, SPSS 25.

The logistic regression method utilized (Wald forward stepwise) resulted in four (4) stages (four different logistic regression models/or equations). The overall performance prediction is shown in Table 3 as a consequence of maize output classification. If the anticipated probability of a category is greater than the created cut-off in each model, the expected answer is considered as 1. As a result, the cut-off value for this investigation is 0.5. Based on the result obtained for the AFDB-CBARDP beneficiaries, model 1 recorded 96.1%, which is preceded by model 2, model 3 and model 4 as 96.9%, 96.9% and 96.9%, respectively. While, for non-beneficiaries, model 1 recorded 57.8%, while model 2, and model 3 recorded 59.0%, and 60.7%, respectively. By implication, this indicates that model 2-4 with 96.9% classification correctness, is accurately predicting the adoption of AFBD-CBARDP by the beneficiaries on maize output. As such, the model 4 was adopted in the anlysis of AFBD-CBARDP beneficiaries, because it correctly categorized more of the explanatory varibles in their order of importannce with regards to stimulating maize output by rural farmers. Therefore, adoption of improved maize seedlings, adoption of farm labour wage, adoption of fertilizer and adoption of improved technologies are ciritial determinants of maize output probability increasing significantly (i.e probability of increasing maize output (i.e. either less than 1000kg or greater than 1000kg). While model 3 was adopted for non-beneficiaries because it produced the highest classification accuracy.

Model Estimation for AFDB-CBARDP Beneficiaries and Non-Beneficiaries

In this study, the forward stepwise wald was used to assess the models' classification accuracy and goodness of fit. The method generated four (4) blocks, but for the purposes of determining accuracy in terms of maize output classification for AFDB-CBARDP beneficiaries, attention was focused on block (4), which yielded the highest classification accuracy with the highest adoption of the explanatory variables, compared to blocks (2) and (3), which have the same classification rate. Four distinct equations were generated at different periods in block four (4), taking into account the factors that show far more variations on the dependent variable (i.e. Maize output), as given in Table 4 below. Table 4 shows the variables (such as AFDB-CBARDP adoption) that are incorporated in each step (i.e. equations).

Table 4: Contribution of each Generated Logistic Model

	AFDB-CBARDP Beneficiaries			Non-Beneficiaries		
Model	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	137.546[a]	.059	.211	696.685[a]	.025	.033
2	116.283[a]	.098	.348	688.745[a]	.040	.053
3	111.929[b]	.105	.375	683.970[a]	.049	.065
4	107.585[b]	.113	.402			

Source: Survey 2022, SPSS 25

The contribution of the AFDB-CBARDP adoption in each model to maize output was shown in Table 4. From the result, model 4 has the highest R Square value, i.e., its Cox & Snell and Nagelkerke coefficients are 0.113 (11.4%) and 0.402 (40%), respectively, with a Log-likelihood value of 107.585. This means that the binary logistic regression model used in step 4 has a greater impact on rural farmers' maize output than the non-included variables, implying that agricultural modernization (i.e., adoption of the AFDB-CBARDP) has a greater impact on rural maize farmers' maize output than the non-included variables.

Moreso, the result for the non-beneficiaries showed the contribution of improved technology adoption in each step to maize output. Hence, observing the result generated, it can deduce that step 3/model 3 has a high R Square value, that is, its Cox & Snell and Nagelkerke coefficients are 0.049(49%) and 0.065(65%), respectively with a Log-likelihood value of 683.970. This implies that, the logistic regression model of step 3 has more influence on mazie output production by the non-beneficiaries. In other words, the improved technology adoption included in step 3 contributes more to stimulating maize output by the non-beneficiaries than the non-included variables.

Table 5: Logistic Regression Output (Variables in the Equation)

	AFDB-CBARDP Beneficiaries				Non-Beneficiaries			
Step	Observed Variables	B	Sig.	Exp(B)	Observed Variables	B	Sig.	Exp(B)
Step 1[a]	Fertilizer (FET)	2.733	.000	15.383	Fertilizer (FET)	.672	.000	1.958
	Constant	1.405	.000	4.077	Constant	-.405	.008	.667

Step 2[b]	Improved maize seedlings (IMS)	2.806	.000	16.544	Improved maize seedlings (IMS)	.554	.005	1.740
	Fertilizer (FET)	3.308	.000	27.339	Fertilizer (FET)	.586	.002	1.796
	Constant	-1.017	.113	.362	Constant	-.730	.000	.482
Step 3[c]	Improved maize seedlings (IMS)	2.651	.000	14.164	Improved maize seedlings (IMS)	.578	.004	1.783
	Farm labour wages (FLW)	3.528	.000	34.043	Farm labour wages (FLW)	-.408	.030	.665
	Fertilizer (FET)	2.344	.020	10.419	Fertilizer (FET)	.660	.001	1.934
	Constant	-3.227	.005	.040	Constant	-.562	.007	.570
Step 4[d]	Improved maize seedlings (IMS)	2.316	.000	10.134				
	Farm labour wages (FLW)	1.185	.039	3.272				
	Fertilizer (FET)	3.395	.000	29.808				
	Improved technology (sprayers, Ox-plough) (AGT)	2.988	.005	19.840				
	Constant	-4.197	.001	.015				

Source: Survey 2022, SPSS 25

$$MOQ= -4.197 + 2.316IMS + 1.185FLW + 3.395\ FET + 2.988AGT + e_i$$
$$(.001) \quad (.000) \quad (.039) \quad (.000) \quad (.005)$$

Table 5, provides comprehensive estimates of the binary logistic regression model generated in four (4) steps with their respective variables included at each step. Thus, the suitable logistic regression model selected is step four (4) for classifying maize output for AFDB-CBARDP beneficiaries, while step three (3) was selected for non-beneficiaries. Applying the cut-off value, if the estimated p-value is not above 0.50, it can be conclude that adoptiong is significant and vice-versa. Taking the square of the fraction of B and S.E., yields the Wald statistic. In terms of small samples, the likelihood ratio test is efficient compared to the Wald test but, with large sample size the Wald test is preferable as the Wald statistic tends to minimize the standard error of the resultant parameter (i.e. it offers the significant test of the β coefficients).

From Table 5, the coefficients are interpreted as the change in the probability of an increase in maize output with respect to a unit change in adoption of the independent variables calculated at mean values. As such, the empirical result revealed that, the variables IMS, FLW, FET and AGT are statistically significant at 5% level of significance, including the constant term was found to be statistically significant at 5% level of significance. The result also revealed that; all things being equal, the Probabillity of increase in maize output in the study area is about (-4.2%) for AFDB-CBARDP beneficiary, and about (-1%) for the non-beneficiary. However, if adoption of IMS is increased by one percent, then the probability for maize output to rise is about 2.3%. If FLW, FET, and AGT adoption is increased by one percent, the probability of maize output to increse is 1.2%, 3.4% and 3.0% repectively for the AFDB-CBARDP beneficiaries. However, the odd ratios obtained for IMS, FLW, FET and AGT coefficients are (10.134, 3.272, 29.808, and 19.840) respectively. This odd ratios indicates that for every unit increase in IMS, FLW, FET and AGT adoption, the likelyhood for maize output to increase is about 10%, 3%, 29%, and 19% respectively. The odd ratio's positive value also implies that IMS, FLW, FET and AGT adoption and maize output have a favorable association.

Furthermore, given the p-value of (0.000, 0.039, 0.000 and 0.005 percent), the result was deemed to be statistically significant. This finding is consistent with Schultz's theory of modernization, as evidenced by his postulations. According to Schultz, agricultural development in rural areas is crucial for higher production. The modernization theoriest opined that, it does not pay to invest in the crude method of farming already in existence in the rural agrarian society that held the rural dwellers trapped in poverty. As such, they proposed that efficient modern factors should be adopted to transmute argricultural activities in the rural area into a high productive type of income, through increased output. Therefore, this findings indicates that for every one unit of adoption of MIS, FLW, FET and AGT agricultural activities of the rural maize farmers will stimulate maize output upwardly, thereby reducing the likelihood of poverty surge. Moreover, the finding is also consistent with the findings and conclusion of Aynalem, et al (2020), Chikezie, et al (2018), Chikezie, et al (2019), Abdullahi (2020), Adesoji (2012) as well as Ebojei, et al (2012), they found similar results that farmers who paticipated in AFDB-CBARDP has high propensity of adoption and increase in output.

Consequently, the coefficients correspondes to the apriori expectetions of this study. This implies that, the explanatory varibles of adoption of improved maize seedlings, farm labour wage, fertilizer and improved technology has a highly significant influence on the productivity of maize by the rural maize farmers.

For the non-beneficiaries, The empirical result revealed that, the variables IMS, FLW, and FET are statistically significant at 5% level of significance, including the constant term was found to be statistically significant at 5% level of significance. This shows that the probability for maize output to rise is (-1%). As such, if adoption of IMS, and FET is increased by one percent, then the probability for maize output to rise is about 0.57%, and 0.66% respectively. While on the other hand, if the doption of (FLW) is increased by , then the probability for maize output to rise is about (-.41%). The odd ratio obtained for IMS, and FET coefficients are (1.783,and 1.934) respectively. This indicates that for every unit increase in IMS,and FET adoption, maize output increases by about 1.8%, and 1.9% respectively. The odd ratio's positive value also implies that IMS, and FET adoption and maize output have a favorable association. Moreover, the result was found to be highly statistically significant, given the p-value of (0.004%, and 0.001%). However, the coefficient for FLW was found to be negetive, indicating that if adoption of FLW is increased by one percent, then the probability for maize output to rise is about (-0.4%). The odd ratio obtained for FLW coefficient is (0.665). This indicates that for every unit increase in FLW adoption maize output is likely to decrease maize output by about (0.6%) . Consequently, the reason for the negetive sign FLW coefficient is anchored on the economic disposition of this rural maize farmers, they are generally poor. As such, it can be seen from this finding that this result is also intandem with the postulation of Schultz theory of modernization, as well as, the findings of Aynalem, et al (2020), Chikezie, et al (2018), Adofu, et al (2013) and Awotide, et al (2012), and Ebojei, et al (2012).

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Table 6: Goodness-of-Fit on each Model

The Hosmer and Lemeshow Test showes the goodness-of-fit tests of the estimated logistic regression models generated in four steps on maize output/ adoption of AFDB-CBARDP.

	AFDB-CBARDP Beneficiaries			Non-Beneficiaries		
Step	**Chi-square**	**Df**	**Sig.**	**Chi-square**	**Df**	**Sig.**
1	.000	0	.	.000	0	.
2	.232	1	.630	.000	2	1.000
3	.178	1	.673	5.425	6	.491
4	4.076	3	.253			

Source: Survey 2022, SPSS 25

Table 6 presents the Hosmer and Lemeshow statistic for four different steps; this statistic reveals important information about each model's standardization and correctness. As such, the significance level of each step/coefficients model's indicates that the null hypothesis of each step/model has been accepted, suggesting that no difference exists between predicted and observed values. Based on the findings obtained for all four models, it appears that, despite the differences in classification accuracy, they all match the data well.

Consequently, for the AFDB-CBARDP beneficiaries, the chi-square statistic critical value for all four models at the 0.05 level of significance, demonstrated that the logistic regression used in this study is indeed significant in terms of the response variable as it relates to the explanatory factors included in each model. As a result, the fourth model, which incorporates adoption of improved maize seedlings, adoption of farm labour wage, adoption of fertilizer, and adoption of improved technology and has the best classification accuracy, fits the data and accounts for greater variability in the dependent variable (i.e. maize output).

While for non-beneficiaries, the chi-square value is found to be 0.491 for step three. Therfore, the third model with the highest classification accuracy which includes adpition of improved maize seedlings, adoption of farm labour wage, and adoption of fertilizer, fits the data and accounts for more variations that occurred in the dependent variable (i.e. maize output). The significance level of the step/model coefficient specifies approval of the null hypothesis of the step/model, implying that there is no difference between predicted and observed values. The omnibus tests, which measure how well the models performed, are shown in Table 7 below.

Table 7: Omnibus Tests of Model Coefficients (Forward Stepwise (Wald)

AFDB-CBARDP Beneficiaries					Non-Beneficiaries		
Observed		**Chi-square**	**Df**	**Sig.**	**Chi-square**	**Df**	**Sig.**
Step 1	Step	31.366	1	.000	12.972	1	.000
	Block	31.366	1	.000	12.972	1	.000
	Model	31.366	1	.000	12.972	1	.000
Step 2	Step	21.263	1	.000	7.941	1	.005
	Block	52.629	2	.000	20.913	2	.000
	Model	52.629	2	.000	20.913	2	.000

Step 3	Step	4.354	1	.037	4.775	1	.029
	Block	56.983	3	.000	25.688	3	.000
	Model	56.983	3	.000	25.688	3	.000
Step 4	Step	4.345	1	.037			
	Block	61.327	4	.000			
	Model	61.327	4	.000			

Source: Survey 2022. SPSS 25.

The omnibus tests were used in this study to quantify and evaluate each model's performance, or how well it performed. This test also looks to see if the explained variance is significantly higher than the unexplained variance. As a result, all of the omnibus statistics are highly significant at the 0.05 percent level of significance, but the step 4 model in particular, for AFDB-CBARDP beneficiaries exhibited a $\chi 2(4, N = 359) = 61.327$, $P < 0.05$. This means that the step 4 model beat the other generated models (steps 3, 2, and 1) in terms of classification accuracy and suitability for forecasting the adoption of the AFDB-CBARDP tools on maize output. While for non-beneficiaries, the omnibus statistics for the step three is highly significant at 0.05 percent level of significance. It showed that a $\chi 2(3, N = 359) = 25.688$, $P < 0.05$. This implies that, step 3 model out performed the other generated models (i.e. step 2 and 1) as well as providing more classification accuracy than the other models and suitable in predicting the adoption of improved technology on maize output by the non-participants.

Conclusion/Recommendation

The study showed that, rural maize farmers who participated on the programme (AFDB-CBARDP) had higher odd ratio of adoption to change in increase in maize output than those who did not participate. The odd ratios (Exp (B) for these variables (MIS, FLW, FET and AGT) are 10.13%, 3.27%, 29.8% and 19.8%. This shows that rural maize farmers who adopts these variables has 10%, 3%, 29%, and 19% probability of increase in maize output than the non-participants. Though, both findings were statistically significant, but the classification correctness for participants on AFDB-CBARDP was however found to be distinct and higher compared to that of non-participants. More so, the step 4/model 4 recommended/adopted for the participants based on the classification accuracy, was found to have prescribed in the order of importance, the adoption of AFDB-CBARDP tools of (improved maize seedlings (IMS), farm labour wage (FLW), fertilizer (FET) and improved agricultural technologies (AGT)) than the model 3 recommended/adopted for the non-participants. Therefore, in a pareto sense, this finding suggests that, rural maize farmers participants on AFDB-CBARDP are better-off than the non-participants. However, the coefficient of agro-chemicals adoption (AGC) and years of maize farm experience (FEX) was found to have no impact on maize output and thus was not recognized into any of the model based on the classification accuracy. Consequently, it can be established from the findings that the adoption of AFDB-CBARDP tools significantly influenced maize output in an upward slop in Kaduna State. Based on the findings, the study recommends the following:

a) Similar programmes like the AFDB-CBARDP is critical to stimulating agricultural produce, particularly maize. As such, government should mobilize supports from the industries and agro food supply-chain sectors to come up with similar initiatives, because the study's finding suggests that poor adoption could diminish maize produce.

b) Efforts should be intensified to provide more efficient technologies that are adequately tailored towards igniting the interest of the farmers in adoting them. Improved maize seedligns, fertilizers, farm labour wage and agricultural technologies must be continuously expanded in a manner that will make it easy for rural maize farmers to easily imbibe improved technologies and possess enough resources to adopt them.

c) The government should intensify its efforts in pursueing a policy of subsidizing agricultural technologies for maize farmers. Given that rural maize farmers are rational economic agents (profit mazimizers), they will seek to adopt improved agricultural technologies so long as the marginal cost of adoption will yield more than the cost of adoption.

d) Rural maize farmers should be encourage to join farmers union so as to benefit from any of such similar programme.

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